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Comparative Analysis of Trunk Impairment Scale vs. Sitting Balance Scale to Predict Functional Recovery in Patients with Stroke- A Pilot Study

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ABSTRACT

Background: Impaired trunk stability and sitting balance after stroke causes problems with gait, balance, and activities of daily living of the individual. TIS and SBS are scales used for the assessment of trunk impairment and sitting balance, respectively. Patients' expectations in terms of functional independence at the acute stage need to be answered by a healthcare professional for which a robust tool to predict the same is required. Therefore, this study is aimed at comparing the Trunk Impairment Scale and the Sitting Balance Scale in predicting functional outcome in patients of stroke.

Methods: It is a pilot study conducted as an observational analytical study done in Neurophysiotherapy OPD, VPMH. A total of 10 stroke patients were included in the study in the age group of 30-65 years with impaired sitting balance. The clinical assessment items taken were taken at baseline, after 1 week, and after 4 weeks. Trunk control was assessed using the Trunk Impairment Scale (TIS), and the sitting balance was assessed using the Sitting Balance Scale (SBS). Motor function of stroke patients was assessed using the Stroke Impairment Assessment Set (SIAS). Functional independence was measured using the Functional Independence Measure (FIM), and dynamic balance and mobility by the Timed Up and Go (TUG) test and ICF Codes for assessing sitting and gait.

Results: The correlations between TIS and SBS with TUG, FIM, SIAS & ICF codes for Sitting and Gait shows TIS was significantly better correlated with TUG (at baseline r=0.57,after 1 week r=0.59), FIM (at baseline r=0.90, after 1 week r=0.87), SIAS (after 1 week r=0.87, after 4 weeks= r=0.69), ICF Codes for Sitting d4153 (after 4 weeks r=-0.35), d413 (after 4 weeks r=-0.35), d4200 (at baseline r= -0.85, after 4 weeks r= -0.74), ICF Codes for Gait d455(after 4 weeks r= -0.86), d460 (at baseline, after 4 weeks r= -0.84), d465(after 4 weeks r= -0.86)

Discussion: TIS is a better predictor of functional recovery than SBS after assessing at 4 weeks as the components are challenging to perform in the acute stage but they can be successfully assessed in the later stages and have a significant impact on activities of daily living (ADLs) whereas most components of SBS involve the use of upper extremity, hence it may not predict trunk control more accurately.

Conclusion: This study concludes that TIS is a better predictor of functional recovery than SBS after assessing at 4 weeks from baseline assessment.

Keywords: Trunk Impairment, Sitting Balance, Stroke, Functional Ability

INTRODUCTION

In the past 3 decades, the disease pattern in 80% of developing countries has shifted from communicable to non-communicable diseases, of which stroke is one of the most common debilitating diseases, the second most common cause of death, and the third most common cause of disability-adjusted life years.[1] Within India, a wide variation in the burden of stroke was observed across the states. To cite, a recent meta-analysis reported a one-month

case fatality rate of stroke varied from 41.08% to 42.06% in the urban population and 18% to 46.3%.in the rural population.[2] The Indian Council of Medical Research estimates that among the non-communicable diseases, stroke contributes to 41% of deaths and 72% of disability-adjusted life years.[3]

The trunk is the center of the body and plays a major role in maintaining the body posture for functional movements by preparing the body for the movement of extremities against gravity. Impairment in trunk performance following stroke is considered to be associated with changes in the measures of balance, gait, and functional ability seen with stroke.[4] Trunk stability and sitting balance after a stroke are compromised, which causes problems with gait, balance, and activities of daily living of the individual. Sitting balance and trunk stability are related to activities of daily living and can be affected post-stroke. It is well recognized that core muscle strength is poor post-stroke. The weakness of trunk flexors, extensors, lateral flexors, and rotators in both subacute and chronic-stage stroke recovery was confirmed by isokinetic and handheld dynamometer muscle strength testing. Trunk muscle weakness is believed to affect balance and daily functional tasks after stroke and was related to inadequate sit-to-stand performance measured using a motion analysis system.[5] Patients having a good trunk performance post-stroke, particularly in dynamic sitting balance, showed better functional status in late-stage stroke recovery.[6] It is important to find out the functional measure after stroke so that exercises are designed accordingly for a better prognosis of the subject. TIS and SBS are scales used for the assessment of trunk impairment and sitting balance, respectively.

TIS assesses static and dynamic balance, uses both upper and lower limbs to assess balance in sitting, has a test-retest reliability of 0.96 and inter-observer reliability of 0.99, and Cronbach alpha coefficients for internal consistency range from 0.65 to 0.89.[5] SBS is relatively easy to perform, contains a sit-to-stand component, sitting with eyes open & eyes closed component, and lateral bending component, has an internal consistency (α) of 0.762, an intrarater reliability ranging from 0.96 to 0.99, and an interrater reliability of 0.87.[6] It uses only the upper extremity to test balance in sitting and does not have the component that requires lifting of the pelvis.

Though TIS has been used as a gold standard tool for the assessment of trunk stability developed in 2004, the components are difficult to be performed by patients in the acute stage, and few components have shown a large ceiling effect. Comparatively, SBS, developed in 2011, has components appropriate in acute stages and is easier to score and hence overcomes the lacunae in TIS. Also, the predictive validity of SBS has not been investigated. Patients' expectations in terms of functional independence at the acute stage need to be answered by a healthcare professional, for which a robust tool to predict the same is required. Masahiro Ishiwatari et al. in his study concluded that TIS is a reliable method for evaluating trunk control function and is an early predictor of ADL among patients with acute stroke. Hanan Helmy et al. in their study stated that the dynamic sitting balance component of the TIS is a reliable clinical indicator of balance and functional recovery. Hence, it is imperative to check the efficiency of SBS to predict functional outcome over TIS.

OBJECTIVES

This study aims to compare Trunk Impairment Scale and Sitting Balance Scale in predicting functional outcomes in the patients of stroke.

METHODOLOGY

This pilot study was conducted as an observational analytical study. The study consisted of 10 subacute and chronic stroke patients. The study was conducted in the Department of Neurophysiotherapy, Vikhe Patil Memorial Hospital, Ahmednagar. The inclusion criteria were diagnosis of unilateral stroke by CT or MRI, first-ever stroke patients in the age group of 30-65 years, either side hemiplegia, patients with impaired sitting balance, patients with poor trunk muscle strength (according to MMT), and patients must understand the commands given by the therapist. The exclusion criteria were patients with a history of other neurological diseases like dementia or peripheral neuropathy, Pushers syndrome, orthopedic problems, cardiovascular disease, and impaired consciousness. Convenience sampling was

used with a sample size of 39, calculated using OpenEPI.

Procedure:

After obtaining the approval from the Institutional Ethical Committee, participants were explained the proposed benefits, risks, and procedures involved in the study in a language best understood by them. Participants willing to participate were screened for inclusion and exclusion criteria after receiving their informed consent. Participants were further assessed by measuring the sitting balance using the Sitting Balance Scale (SBS), trunk impairment using the Trunk Impairment Scale (TIS), functional measure using the Functional Independence Measure, impairment due to stroke by the Stroke Impairment Assessment Set (SIAS), dynamic balance and mobility by the Timed Up and Go (TUG), and ICF codes test thrice: on the day of assessment, after 1 week, and after 4 weeks.

To assess the sitting balance in the sitting position, the Sitting Balance Scale (SBS) was used. All sitting items are performed with the patient sitting unsupported on a firm surface with both feet in a weight-bearing position unless otherwise indicated. An individual gets one attempt at each task. Individuals should be told to try to maintain their balance while attempting each task. Scoring: 5-point ordinal scale, range 0-4. 0 indicates the lowest level of function and 4 the highest level of function.

To assess the trunk impairment, the Trunk Impairment Scale is used. The TIS assesses static and dynamic sitting balance and trunk coordination in a sitting position. The starting position for each item is the same, with the patient sitting on the edge of a bed or treatment table without back and arm support, the thighs making full contact with the bed or table, and the feet hip-width apart and placed flat on the floor. The knee angle is 90. The arms rest on the legs. If the patient scores 0 on the first item, the total score for the TIS is 0. Each item of the test can be performed three times. The highest score counts. No practice session is allowed. The patient can be corrected between the attempts. The tests are verbally explained to the patient and can be demonstrated if needed.

To assess the functional measure after stroke, the Functional Independence Measure tool is used. The Functional Independence Measure is a scale in which the subjects are seated on a chair and are asked whether they can perform self-care, which includes grooming, bathing , dressing (upper body), dressing (lower body), and toileting; whether they have sphincter control (bowel and bladder management); whether they can perform transfers from bed, chair, wheelchair, toilet, tub, or shower; whether they are locomotive (walking/wheelchair or stairs); whether they can communicate (comprehension or expression); and whether they have social cognition (social interaction , problem-solving, and memory).

To assess the impairment caused by stroke, the Stroke Impairment Assessment Set is used, which primarily employs single-task assessment of various functions such as motor function of the upper and the lower Limb, tone, sensory function, range of motion, pain, trunk control, visuospatial perception, aphasia, and function of the unaffected Limb.

To assess the dynamic balance and mobility of an individual, the Timed Up and Go test is used. It consists of a single task: to stand up, walk 3 m, turn around, and return to the chair. Healthy adults can complete the test in less than 10 sec. older adults have been shown to average scores less than 10 (mean of 8). Scores of 1 to 20 seconds are considered within typical for frail elderly or individuals with disabilities. Scores over 3 seconds are indicative of impaired functional mobility and high risk of fall.

To assess the ICF Codes for Sitting and Gait, Maintaining a sitting position (d4153), Sitting (d413), Transferring oneself while sitting (d4200), Walking (d450), Moving around(d455), Moving around in different locations (d460), and Moving around using equipment (d465).

Statistical Analysis:

Shapiro-Wilk test was performed prior to each test to determine if each variable followed a normal distribution. Correlation analysis using Spearman's rank correlation coefficient to determine correlation between Trunk Impairment scale and Functional Independence Measure, Trunk impairment scale with Stroke Impairment Assessment Set and Sitting balance Scale with Timed Up and

Go test and ICF Codes. Correlation analysis using Pearsons's rank correlation coefficient to determine correlation between Sitting balance Scale and Functional Independence Measure and Stroke Impairment Assessment Set and Trunk Impairment scale with Timed Up and Go test and ICF Codes at baseline, after 1 week and after 4 weeks.

RESULTS

In this comparative pilot study between the Trunk Impairment Scale and the Sitting Balance Scale as a predictor of functional outcome in patients with stroke, Table 1 shows demographic data of the 10 patients who were included out of which 8 had ischemic stroke and 2 had hemorrhagic stroke, 8 were male and 2 were females. The mean age of the patients in the study was 54.8±10.9 years. There were 4 patients with right sided hemiplegia were 4 and left sided hemiplegiaas were 6.

Table 2 shows Mean and SD for Measurement tools at baseline, after 1 week and after 4 weeks.

Table 3 shows Correlations between TIS and TUG, FIM, SIAS & ICF codes for Sitting and Gait. The results show that TIS has extremely to incredibly significant correlations with FIM at baseline, 1 week and 4 weeks. TIS has extremely significant correlations with SIAS after 1 week and incredibly significant and significant correlations at baseline and after 4 weeks, respectively. TIS has incredibly significant correlations with TUG at 4 weeks assessment, but not significant correlation at baseline and after 1 week. TIS shows incredibly significant correlations with ICF codes for Sitting at baseline and after 1 week and have no significant correlation after 4 weeks for ICF Codes d4153 and d413 and significant correlation for ICF Code d4200 for Sitting. TIS shows incredibly significant correlations with ICF Codes for Gait at baseline and after 4 weeks, whereas there are excellent and significant correlations for ICF codes d460 and d465 respectively and significant correlation for ICF codes d450 and d455 after 1 week.

Table 4 shows correlation of SBS with the independent variables which shows excellent correlation with FIM and particularly good correlation with SIAS and ICF codes for Sitting and Gait whereas no correlation with TUG at baseline.

Table 1: Demographic Data

		Mean ± SD	PERCENTAGE
Type of Stroke	Ischemic Haemorrhagic	8 2	80% 20%
Duration of Stroke.			
Sex	MALE	8	80%
	FEMALE	2	20%
Age		54.8±10.9	
Side Affected- Right Left		4 6	40% 60%

Table 2: Mean and SD for Measurement Tools

Measurement tools	Mean± SD		
	Baseline	After 1 weeks	After 4 weeks
Trunk Impairment Scale	18± 3.3	19.8±2.5	22.1±1.5
Sitting Balance Scale	32±8.6	35.7±7.1	40.8±4.9
Timed Up and Go	21.4±19.3	19.7±18.1	36±21.8
Stroke Impairment Assessment Set	51.1±9.8	63.1±8.3	70.7±4.9

ICF Codes:	Maintaining Sitting position (d4153)	0.7±1.1	0.7±1.1	0.2±0.6
	Sitting (d413)	0.7±1.1	0.6±0.9	0.1±0.3
	Transferring oneself while sitting (d4200)	1.4±1.6	0.8±1.3	0.2±0.4
	Walking (d450)	1.8±1.6	1.6±1.7	0.8±1.1
	Moving around (d460)	1.9±1.5	1.6±1.7	0.8±1.1
	Moving around in different locations (d460)	2.3±1.3	2.1±1.4	1±1.3
	Moving around using equipment (d465)	1.9±1.5	1.7±1.70	0.8±1.1
Functional Independence Measure		100.5±27	107±25.1	116.4±16.4

Table 3 summarizes correlation of TIS with the independent variables at baseline, after 1 week and after 4 weeks. It shows that there is no correlation of TUG with TIS at baseline and after 1 week, but particularly good correlation after 4 weeks. TIS showsan excellent correlation with FIM at baseline and after week and particularly good correlation after 4 weeks. TIS with SIAS showsparticularly good correlation at baseline, excellent correlation after 1 week and significant correlation after 4 weeks. TIS and ICF codes at baseline assessment showsignificant correlation with ICF codes for assessing Sitting as well as for ICF codes for assessing Gait. The correlation of TIS and ICF codes for assessing Sitting show significant correlation after 1 week were as shows significant correlation with ICF codes for assessing Walking and Moving around, excellent correlation with ICF code for Moving around at different locations and significant correlation with ICF code for Moving around using equipment. ICF Codes for Maintaining a sitting position and Sitting do not show significant correlation with TIS whereas ICF Code for transferring oneself while sitting shows mild correlation with TIS after 4 weeks. ICF Codes for assessing Gait show significant correlation with TIS after 4 weeks.

Table 3: Correlation between Trunk Impairment Scale and Timed Up and Go test, Functional Independence Measure, Stroke Impairment Assessment Set, ICF Codes for Sitting and Gait

Independent Variable	**Dependent Variable**	**r value**		
		Baseline	**After 1 weeks**	**After 4 weeks**
Timed Up and Go	Trunk Impairment Scale	0.57(not quite sig)	0.59 (not quite sig)	-0.79 (vs)
Functional Independence Measure	Trunk Impairment Scale	0.90 (es)	0.87 (es)	0.79 (vs)
Stroke Impairment Assessment Set (SIAS)	Trunk Impairment Scale	0.84 (vs)	0.87 (es)	0.69 (s)
ICF Codes	Trunk Impairment Scale			
• Maintaining a sitting position (d4153)		-0.82(vs)	-0.82(vs)	-0.35 (ns)
• Sitting (d413)		-0.82(vs)	-0.82(vs)	-0.35(ns)
• Transferring oneself while sitting (d4200)		-0.85 (vs)	-0.80 (vs)	-0.74 s
• Walking (d450)		-0.79 vs	-0.76 s	-0.86 vs
• Moving around(d455)		-0.87 vs	-0.76 s	-0.86 vs
• Moving around in		-0.84 vs	-0.90 es	-0.84 vs

different locations(d460)				
• Moving around using equipment(d465)		-0.79 vs	-0.80 vs	-0.86 vs

Table -4 summarizes the correlation of SBS with the independent variables at baseline, after 1 week and after 4 weeks. It shows that there is no significant correlation between TUG with SBS at baseline and after 1 week, but significant correlation after 4 weeks. FIM shows significant correlation with SBS at baseline, after 1 week and after 4 weeks. There is a significant correlation between SIAS with SBS at baseline but not significant correlation after 1 week and 4 weeks. ICF Codes for Maintaining a sitting position and Sitting show excellent correlation and ICF Code for Transferring oneself while sitting shows significant correlation whereas ICF Codes for Walking, Moving Around at different locations and moving around with equipment shows significant correlation and Moving around shows excellent correlation with SBS at baseline. After 1 week Assessment, ICF codes for Gait as well as ICF Code for Sitting and Transferring oneself while sitting shows excellent correlation whereas ICF Code for Maintaining sitting position shows significant correlation with SBS. ICF Codes for Sitting show no significant correlation and ICF codes for Gait show significant correlation with SBS at 4 weeks.

Table 4: Correlation between Sitting Balance Scale and Timed Up and Go test, Functional Independence Measure, Stroke Impairment Assessment Set, ICF Codes for Sitting and Gait

Independent Variable	Dependent Variable	r value		
		Baseline	After 1 weeks	After 4 weeks
Timed Up and Go	Sitting Balance Scale	-0.36 ns	0.42 ns	-0.93 vs
Functional Independence Measure	Sitting Balance Scale	0.85 vs	0.85 vs	0.87 vs
Stroke Impairment Assessment Set (SIAS)	Sitting Balance Scale	0.89 vs	0.58 (not quite sig)	0.61 (not quite sig)
ICF Codes	Sitting Balance Scale			
• Maintaining a sitting position (d4153)		-0.88 (es)	-0.85 (vs)	-0.33 (ns)
• Sitting (d413)		-0.88 (es)	-0.88 (es)	-0.33 (ns)
• Transferring oneself while sitting (d4200)		-0.83 (vs)	-0.88 (es)	-0.50 (ns)
• Walking (d450)		-0.85 vs	-0.92 es	-0.85 vs
• Moving around(d455)		-0.87 es	-0.92 es	-0.85 vs
• Moving around in different locations(d460)		-0.82 vs	-0.90 es	-0.76 vs
• Moving around using equipment(d465)		-0.83 vs	-0.91 es	-0.85 vs

Table 5 summarizes comparison of predictive validity of TIS and SBS at baseline, 1 week and 4 weeks in determining functional outcome of patients with stroke. TIS is a better predictor when compared with TUG at baseline and 1 week, FIM at baseline and 1 week, SIAS at 1 week and 4 weeks, ICF codes for Maintaining sitting position at 4 weeks,

Sitting at 4 weeks, Transferring oneself while sitting at baseline and 4 weeks, Moving around at 4 weeks, Moving around in different locations at baseline and 4 weeks and moving around using equipment at 4 weeks.

Table 5: Comparison of Predictive Validity of TIS and SBS at Baseline, After 1 week and After 4 weeks

	BASELINE		1 WEEK		4 WEEKS	
	TIS	SBS	TIS	SBS	TIS	SBS
TUG	0.57	-0.36	0.59	0.42	-0.79	-0.93
FIM	0.90	0.85	0.87	0.85	0.79	0.87
SIAS	0.84	0.89	0.87	0.58	0.69	0.61
ICF CODES						
• Maintaining a sitting position (d4153)	-0.82	-0.88	-0.82	-0.85	-0.35	-0.33
• Sitting (d413)	-0.82	-0.88	-0.82	-0.88	-0.35	-0.33
• Transferring oneself while sitting (d4200)	-0.85	-0.83	-0.80	-0.88	-0.74	-0.50
• Walking (d450)	-0.79	-0.85	-0.76	-0.92	-0.84	-0.85
• Moving around(d455)	-0.87	-0.87	-0.76	-0.92	-0.86	-0.83
• Moving around in different locations(d460)	-0.84	-0.82	-0.90	-0.90	-0.84	-0.76
• Moving around using equipment(d465)	-0.79	-0.83	-0.80	-0.91	-0.86	-0.85

DISCUSSION

In this study, we compared the Trunk Impairment Scale and Sitting balance Scale with the independent variables and studied the predictive validity of both the scales in determining functional outcome in patients with stroke. TIS and SBS were compared with Stroke Impairment Assessment Set (SIAS), Timed Up and Go (TUG) Test, Functional Independence Measure (FIM) and ICF Codes of assessing Sitting and Gait at baseline, after 1 week and after 4 weeks. To our knowledge, this is the first study to compare TIS and SBS as a predictor for functional ability in patients with stroke.

TIS is a better predictor than SBS when compared with TUG at baseline and 1 week. It was found that there was no significant correlation between TUG and TIS at baseline and at 1week. However, there is significant correlation between TIS with TUG at 4 weeks which is contradictory to a previous study where TUG was inconsistent in individuals with chronic stroke that have increased lower limb muscle tone. Individuals with chronic stroke who have increased ankle plantar flexor tone need more time to achieve a real change in the TUG than those who have normal muscle tone. SBS is a better predictor of functional ability at 4 weeks than TIS when compared with TUG. In a previous study, it was confirmed that SBS has the highest predictive validity in discriminating mobility level as it is consisted of controlling the upper and lower trunk and coordination, as well as a specific task item for examining the comprehensive dynamic balance capability, required for sit to stand task and mobility.

When compared with FIM, TIS is a better predictor than SBS at baseline and 1 week. The result is consistent with a study done by Mahashiro Ishiwatari et. al. in which he concluded that the TIS is a good predictor of ADL even in the acute phase of stroke rehabilitation. In his study, the correlation between predicted and measured FIM-M values at the time of discharge was extremely high (r = 0.89), which was favorable based on the multiple regression equation obtained with multiple regression analysis using the stepwise method.

In our study, we found that TIS is a better predictor of functional outcome than SBS at 1 week and 4 weeks when compared with SIAS. TIS is extremely significant at 1 week and

significant at 4 weeks when correlated with SIAS. However, SBS is a better predictor of functional outcome than TIS when compared with SIAS at baseline assessment.

The ICF code for maintaining sitting position and sitting when compared with TIS and SBS, TIS was a better predictor at 4-week assessment. They do not have a significant correlation with TIS at the 4-week assessment but have an incredibly significant correlation at baseline and 1 week. The SBS has extremely significant correlation with ICF codes Maintaining sitting balance and sitting at baseline and 1 week and is a better predictor of functional ability than TIS. The ICF code Transferring oneself while sitting is better correlated with TIS than SBS at baseline and 4 weeks. The TIS is a better predictor of functional outcome than SBS when compared with ICF code Moving around at 4 weeks. When compared with ICF code Moving around in different locations, TIS is a better predictor than SBS at baseline and 4 weeks and when compared with ICF code Moving around using equipment, TIS is a better predictor than SBS at 4 weeks.

There are a few limitations to this study. We assessed trunk control and sitting balance in stroke survivors. But we did not take into consideration trunk repositioning error which could be an important indicator to predict functional recovery in patients with stroke. Further investigations should be performed including trunk repositioning error as a predictor of functional recovery in patients with stroke. A significant correlation of all the independent variables with TIS at 4 weeks of assessment was found in this study. However, the number of subjects included in this study was insufficient for the results to be generalized. Future studies with a large sample size should be performed.

CONCLUSION

This study concludes that TIS is a better predictor of functional recovery than SBS after assessing at 4 weeks from baseline assessment. The planning and execution of voluntary movement requires the brain to extract sensory information about body position and predict future positions. This process involves integrating various sensory inputs with ongoing and planned motor activities. Neurological patients who have lost one or more of their senses may experience significant motor function impairments, even if their muscle strength remains intact. After a stroke, the degree of motor recovery can be influenced by the extent of sensory disruption. Therefore, further studies should include sensory and perceptual issues as predictors of functional recovery after a stroke.

CONFLICTS OF INTEREST

There are no conflicts of interest.

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